MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2019/2020

PME0016 – MECHANICS

(Foundation in Engineering)

16 OCTOBER 2019
9.00 a.m - 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 6 printed pages excluding the cover page.
2. Answer ALL five (5) questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

QUESTION 1 (10 MARKS)

a) A 15 kg box is placed on one end of 1.0 m long plank. The plank itself also has a mass of 15 kg. this arrangement is held in a horizontal position by two cables, as shown in **Figure Q1(a)**.

Figure Q1(a)

i) Draw a free-body diagram for this system. [2 marks]

ii) Calculate the cable tensions. T_1 and T_2. [3 marks]

b) A diving board 3.0 m long is supported at a point 1.0 m from the end, and a diver weighing 475 N stands at the free end, as shown in **Figure Q1(b)**. The diving board is of uniform cross section and weighs 250 N.

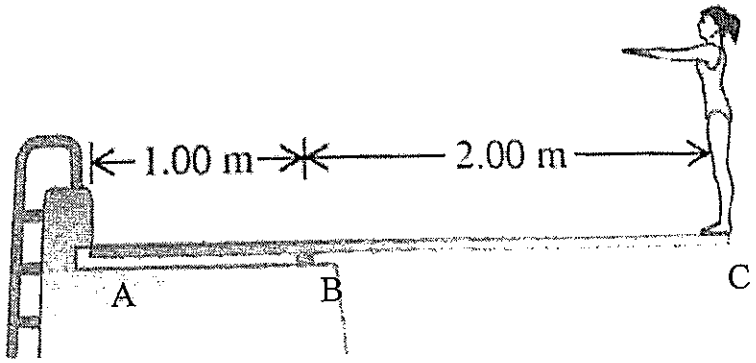

Figure Q1(b)

i) Draw a free-body diagram of the diving board. [2 marks]

ii) Calculate the force at the support point B. [1.5 marks]

iii) Determine the force at the left-hand end, point A. [1.5 marks]

Continued...

QUESTION 2 (10 MARKS)

a) State the conditions for the work done by the spring be positive and negative. [2 marks]

b) Provide an example of event where the principles of conservation of energy is applicable. [1 mark]

c) An object of mass 2.0 kg is connected to a light spring of spring constant 100 Nm^{-1}, as shown in Figure Q2. The object is placed on a rough inclined plane such that the object is at rest and the spring is about to be stretched. Then the object is suddenly released from rest. When the spring is stretched by 0.15 m, the object comes to a stop.

i) Sketch the free body diagram for the whole system. [1.5 marks]

ii) Determine the work done by the force of gravity when the object moves 0.15 m from the initial position. [1 mark]

iii) Determine the work done by the spring when the object moves 0.15 m from the initial position. [1 mark]

iv) Determine the work done by the force of friction, in terms of μ, when the object moves 0.15 m from the initial position. [1 mark]

v) Hence, obtain coefficient of friction, μ . Hint: use work-energy theorem. [2.5 marks]

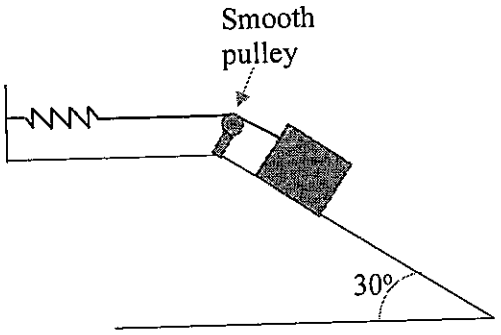

Figure Q2

Continued...

QUESTION 3 (10 MARKS)

a) An electric fan is turned off, and its angular velocity decreases uniformly from 550 rev/min to 250 rev/min in 3.5 s. Calculate

i) the angular acceleration in rev/s^2. [1.5 marks]

ii) the number of revolutions made by the motor in the 3.5 s interval. [1.5 marks]

iii) the time required for the fan to come to rest if the angular acceleration remains constant at the value calculated in part (i). [1.5 marks]

b) A flywheel with a radius of 0.35 m starts from rest and accelerates with a constant angular acceleration of 0.7 rad/s^2. Calculate the magnitude of the tangential acceleration, the radial acceleration and the resultant acceleration of a point on its rim

i) at the start, and [2 marks]

ii) after it has turned through 60°. [3.5 marks]

QUESTION 4 (10 MARKS)

a) Define the following terms:

i) Pressure
ii) Elasticity
iii) Plastic deformation

[3 marks]

b) A wire has mass 5.3 g and the length 2.50 m. A force of 50 N can extend it by 2.3 mm. Determine the Young's modulus of the wire. Given density of the wire is $2.7 \times 10^3 kgm^{-3}$. [3 marks]

c) A cubical copper block is 1.5 cm on each edge is hang using string and submerge in oil. Given the density of oil $\rho_{oil} = 820\, kgm^{-3}$ and density of copper $\rho_{Cu} = 8920\, kgm^{-3}$. Determine:

i) The buoyant force on the copper when it is submerged in oil.
ii) The tension in the string that is supporting the block when submerge.

[4 marks]

Continued...

QUESTION 5 (10 MARKS)

At $t = 0$, a 655 g mass at rest on the end of a horizontal spring $k = 139$ N/m is struck a hammer which gives it an initial speed of 3.45 m/s. Determine

a) the period and frequency of the motion [3 marks]

b) the amplitude [1.5 marks]

c) the maximum acceleration [1.5 marks]

d) the position as a function of time [1.5 marks]

e) the kinetic energy when $x = 0.40A$ where A is the amplitude. [2.5 marks]

End of Paper

LIST OF PHYSICAL CONSTANTS

Electron mass,	m_e	=	9.11×10^{-31} kg
Proton mass,	m_p	=	1.67×10^{-27} kg
Neutron mass,	m_n	=	1.67×10^{-27} kg
Magnitude of the electron charge,	e	=	1.602×10^{-19} C
Universal gravitational constant,	G	=	6.67×10^{-11} N.m^2 kg^{-2}
Universal gas constant,	R	=	8.314 J/K.mol
Hydrogen ground state,	E_o	=	13.6 eV
Boltzmann's constant,	k_B	=	1.38×10^{-23} J/K
Compton wavelength,	λ_c	=	2.426×10^{-12} m
Planck's constant,	h	=	6.63×10^{-34} J.s
		=	4.14×10^{-15} eV.s
Speed of light in vacuum,	c	=	3.0×10^8 m/s
Rydberg constant,	R_H	=	1.097×10^7 m^{-1}
Acceleration due to gravity,	g	=	9.81 m s^{-2}
1unified atomic mass unit,	1 u	=	931.5 MeV/c^2
		=	1.66×10^{-27} kg
1 electron volt,	1 eV	=	1.60×10^{-19} J
Avogadro's number,	N_A	=	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing,	I_o	=	1.0×10^{-12} W m^{-2}
Coulomb constant,	$k = \frac{1}{4\pi\varepsilon_o}$	=	9.0×10^9 N m^2 C^{-2}
Permittivity of free space,	ε_o	=	8.85×10^{-12} C^2 N^{-1} m^{-2}
Permeability of free space,	μ_o	=	$4\pi \times 10^{-7}$ (T.m)/A
1 atmosphere pressure,	1 atm	=	1.0×10^5 N/m^2
			1.0×10^5 Pa
Earth: Mass,	M_E	=	5.98×10^{24} kg
Radius (mean),	R_E	=	6.38×10^3 km
Moon: Mass,	M_M	=	7.35×10^{22} kg
Radius (mean),	R_M	=	1.74×10^3 km
Sun: Mass,	M_S	=	1.99×10^{30} kg
Radius (mean),	R_S	=	6.96×10^5 km
Earth-Sun distance (mean),	R_{ES}	=	149.6×10^6 km
Earth-Moon distance (mean),	R_{EM}	=	385×10^3 km

LIST OF FORMULA

$y = kx^n$ $\frac{dy}{dx} = knx^{n-1}$	$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$	$\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$	$\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$

$v = v_o + gt$ $\quad y - y_o = v_o t + \frac{1}{2}gt^2$ $\quad v^2 = v_o^2 + 2g(y - y_o)$ $\quad y - y_o = \left(\frac{v_o + v}{2}\right)t$

$a_c = \frac{v^2}{r}$

$\tau = r \times F$ $\quad \sum \tau = \tau_{net} = I\alpha$ $\quad I = \sum mr^2$ $\quad v = r\omega$

$L = r \times p = I\omega$ $\quad K = \frac{1}{2}I\omega^2$

$T_s = 2\pi\sqrt{\frac{m}{k}}$ $\quad T_p = 2\pi\sqrt{\frac{l}{g}}$ $\quad T = \frac{2\pi}{\omega} = \frac{1}{f}$

$x = A\cos\omega t$ $\quad x = A\sin\omega t$

$v = -\omega A\sin\omega t$ $\quad v = \omega A\cos\omega t$

$a = -\omega^2 A\cos\omega t$ $\quad a = -\omega^2 A\sin\omega t$

$v = \frac{\Delta x}{\Delta t}$ $\quad a = \frac{\Delta v}{\Delta t}$

$v = v_o + at$ $\quad x - x_o = v_o t + \frac{1}{2}at^2$ $\quad v^2 = v_o^2 + 2a(x - x_o)$ $\quad x - x_o = \left(\frac{v_o + v}{2}\right)t$

$W = mg$ $\quad \sum F = F_{net} = ma$ $\quad f_s \le \mu_S F_N$ $\quad f_k = \mu_K F_N$

$p = mv$ $\quad \sum F = \frac{\Delta p}{\Delta t}$

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ $\quad m_1u_1 + m_2u_2 = (m_1 + m_2)\,v$ $\quad P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\bar{v}$

$K = \frac{1}{2}mv^2$ $\quad PE_s = \frac{1}{2}kx^2$ $\quad F_s = -kx$ $\quad PE_G = mgy$